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SUBJECT: CONCRETE REPAIR & PREPARATION

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Introduction

Concrete substrates are one of the most common surfaces in which tile assemblies are adhered to. These substrates can be problematic and a source of failure to a tile installation if not properly prepared. Correctly evaluating the substrate and addressing adverse conditions by implementing industry accepted methods of repair and preparation is a crucial step in assuring a successful tile installation. This report covers typical nonstructural issues that require modifications in order to produce industry accepted substrates. Structural conditions that yield excess movement, such as large expanding cracks and cracks with vertical displacement, should be evaluated by a structural engineer. Only after sufficient corrections are made to the concrete substrates, should tile be installed. It should be understood that the performance of a tile installation heavily relies upon a qualified, sound, clean and dimensionally stable substrate.

Cleaning

Concrete surfaces must be free of all contaminants in order to accept a direct application of bonded membranes, adhesives and mortars. Contaminates such as; dust, loose debris, grease, wax, oil, coatings, sealers, curing compounds, paint, drywall, efflorescence, standing water or other bond inhibiting material must be removed from the concrete before application of bonding materials. If contaminants cannot be thoroughly removed with a scraper, broom, mop, or other means, mechanical scarification should be used to achieve an uncontaminated bondable surface. To test for sealers, coatings or other contaminants that will impede a desired bond; apply water on various areas of the substrate. The substrate should accept water penetration, if the water beads, surface contaminants are present. Always follow product manufacturers' directions for proper surface requirements. See the *International Concrete Repair Institute - Concrete Repair Manual 3rd Edition* technical note CS MR 4.4 *Cleaning Concrete Surfaces* for details on cleaning concrete surfaces. For more on bond breakers on concrete slabs see: www.ctioa.org/reports/fr92.html

Surface Profile

Most tile products designed to bond directly to concrete, require that the concrete have a rough textured surface. An acceptable surface profile would include a steel trowel with fine broom

finish or a wood float finish. Smooth concrete surfaces must be mechanically scarified to provide a rough surface equivalent to that of the broom or wood float finish. The objective is to establish a roughened surface that delivers sufficient bonding capabilities required by most mortar manufacturers. Some membranes and adhesives can be applied directly to smooth finished surfaces. Always follow product manufacturers' directions for proper surface requirements. For non bonded reinforced mortar beds isolated from concrete surfaces with a cleavage membrane, surface profiling is not required.

Surface Tolerance

Tile industry standards have been established that specify the surface plane of substrates and sub surfaces do not exceed 1/4 inch in 10 feet and 1/16 inch in 1 foot from the required plane for ceramic tile and 1/8 inch in 10 feet and 1/16 inch in 1 foot for natural stone. It can be expected that not all concrete surfaces will meet these tolerances, and adjustments must be made to comply. High spots can be lowered by grinding with diamond cup wheels or by removing material with a bush hammer. Areas that are removed with bush hammers can be patched and smoothed with a concrete patching compound. Low spots can be filled with concrete patching compounds and levelers with tapering capabilities. Use patching and leveling products designed for this purpose and always follow manufacturers' directions. For tile assemblies that require slope the same tolerances should apply to the sloping surface plane. For more on concrete tolerance see: www.ctioa.org/reports/fr89.html

Cracks

As sure as concrete is to crack, the extent of the cracking over time is unpredictable. Close attention should be focused on evaluating concrete surfaces and distinguishing structural cracks from non-structural cracks. Structural cracks such as large expanding cracks and cracks with vertical displacement should be evaluated by a structural engineer who can then specify the proper repair per the *International Concrete Repair Institute* and design an appropriate tile system. For non-structural horizontally in-plane cracks, a crack isolation membrane (**ANSI A118.12**) may be a solution. To differentiate in-plane cracks with those with vertical displacement, place a straight edge or level across the crack in question. If the surfaces on either side of the crack are flush, the crack is in-plane. Vertical displacement exists if one surface is higher than the adjacent surface across the crack. For non-structural in-plane cracks within concrete substrates, crack isolation membranes and mortars can be used to help protect against crack transfer from the substrate to the tile surface. Without crack isolation membranes or mortars most cracks within concrete substrates are sure to transfer through the surface of the tilework. Many crack isolation membrane manufacturers' offer products to help protect against in-plane cracks 1/8 inch wide, and some as wide as 3/8 inch. Most crack isolation systems require that cracks be pre-filled before bridging with membranes or mortars. Always follow manufacturers' directions specific to the product used. For substrates with limited minor cracking, a partial coverage method can be used as detailed in **TCNA F125-07**. For substrates with minor cracking throughout or for protection against future in-plane cracking, a full coverage method is recommended as detailed in **TCNA F125A-07**. Certain membranes may be sensitive to moisture and alkalinity inherent with concrete substrates. Consult manufacturer for acceptable limits. If height limitations permit, a non-bonded, reinforced mortar bed tile system using a cleavage membrane can be used to isolate tilework from concrete substrates with non-structural

cracking. See method detailed in *TCNA F111-07*. For more on crack isolation membranes see: www.ctioa.org/reports/fr117.html

Movement Joints

Movement joints are designed and specifically placed within concrete substrates with the purpose to absorb and control anticipated movement. These joints must continue through the surface of the tilework implementing a flexible sealant with back-up at the surface as detailed in *TCNA Movement Joint Design Essentials EJ171-07*. Unfortunately movement joints are seldom designed and placed with the tile finish in mind. This can present a challenge for a designer or installer to assemble a tile layout around these joints that is esthetically pleasing to all. However, there are crack isolation membranes when used per manufacturers' directions that allow tile to bridge cold joints and saw cut control joints. This is accomplished by bridging the joints with the membrane and placing flexible sealant at the tile joints on either side of the bridged movement joint. Expansion joints, those which are continuous through the substrate and typically filled with sealant or device, should never be covered. It is a requirement that movement joints be placed at the perimeters of tile assemblies and within the field of tile when spans dictate, see guidelines in *TCNA Movement Joint Design Essentials EJ171-07*. For more on Movement joints see: www.ctioa.org/reports/fr107.html

Spalling and Delamination

In concrete definition, spalling is the development of spalls, a fragment, usually in the shape of a flake, detached from a larger mass below. Delamination in concrete is a horizontal splitting, cracking, or separation in a plane roughly parallel to, and generally near, the upper surface. Common causes of these deteriorations are chemical attack, freezing and thawing, corrosion of embedded reinforcement and improper mixing and placement. When any signs of these conditions exist, a thorough evaluation of the substrate should be conducted and proper repairs made prior to installing tile assemblies. Initial testing can be done by sounding the substrate for hollow, loose and delaminated material by dragging a chain across the surface or tapping it with a hammer. All loose and delaminated material must be removed until a sound surface is exposed. If the deterioration is only superficial, filling shallow voids with a patching compound can be performed to supply an appropriate surface for tile assemblies. Use methods and patching products designed for this purpose and always follow product manufacturers' directions. In the case where the deterioration is excessive, such as when unsound material continues deep into the substrate or when corroded reinforcing is exposed, a structural engineer should be consulted for further evaluation. The engineer/design professional can then correct the cause and appropriate a repair with a design for a tile finish.

Moisture

Moisture within concrete substrates can be detrimental to tile assemblies when materials sensitive to higher alkali levels (high pH levels) are used. As moisture in a vapor state condenses and liquefies at the bond line of the tile, pH levels rise as soluble alkalis within the concrete dissolve. This can break down organic adhesives and some membranes and cause a loss of bond. Ceramic tile assemblies installed with cementitious mortars typically perform well over concrete substrates with moisture, however elevated vapor levels have been known to stain and even spall grout joints as the soluble alkali salts are deposited at the surface, crystallizing and expanding.

The most common moisture related tile failure is when natural stone is installed directly to concrete substrates with elevated moisture vapor levels. As the vapor passes through the stone the soluble alkali salts are deposited in the pores at the surface of the stone. As this process continues over time, the soluble deposits crystallize and expand which can cause discoloring, dulling and spalling at the stone tile surface. That is why it is recommended that a waterproof membrane (**ANSI A118.10**) be used on all stone installations over concrete slabs on grade, as slabs on grade are more susceptible to higher levels of moisture due to their contact with soils and water sources. Before installing moisture sensitive materials to concrete substrates, the substrate should be examined for signs of elevated moisture vapor. This can be done by conducting a matt test, moisture meter reading or calcium chloride dome test. If excessive levels are present, provisions should be implemented to defuse the condition, thus protecting the sensitive materials. There are many vapor barrier membranes that are designed for this application. Always follow manufacturers' guidelines and directions. The use of an uncoupling membrane may also be used to shield sensitive material from the damaging effects of moisture vapor. The free space beneath the matting provides a route for the moisture vapor to escape. This membrane can be installed over young concrete cured a minimum 14 days, as detailed in **TCNA F128-07**. Most other installation methods require new slabs cure a minimum of 28 days to allow adequate hydration before tile is installed. For more on moisture and its effect on ceramic tile and stone installations see: www.ctioa.org/reports/fr80.html

Post-tensioned and pre-stressed slabs

It is important to identify post-tensioned and pre-stressed concrete slabs prior to designing a tile installation. If concrete slab information is not available by construction documents, post-tensioned and pre-stressed slabs can be recognized by the tendon anchors along the perimeter edge of the slab. Stamps identifying the slab as post-tensioned or pre-stressed can be found in a corner of the slab surface. Although they are suitable substrates for tile installations, they present conditions that may cause failure when direct bond applications are applied. Due to the inherent creep and shrinkage of the concrete over time, compression stress is forced on the bonded tile which can lead to bond loss, buckling and spalling. A non-bonded, reinforced mortar bed tile system using a cleavage membrane is the preferred method of installation. See method detailed in **TCNA F111-07**. If height limitations do not permit a **TCNA F111-07**, the use of a crack isolation membrane (**ANSI A118.12**) or uncoupling membrane is recommended. See **TCNA F125A-07** and **F128-07**. For more on post-tensioned and pre-stressed slabs see: www.ctioa.org/reports/fr103.html

Conclusion

Designing a successful tile installation begins with the evaluation of the concrete substrate. Identify the substrate type and if preparations or repairs are needed, use products and methods appropriate for each unique condition. Only after a scope of work has been determined should a total tile system be designed. Use only **ANSI** approved products that are compatible with each other. The use of one source for preparation and setting materials is always recommended.